

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A liquid outlet link assembly to provide a steady liquid delivery output rate below 10 $\mu\text{l}/\text{minute}$ through a liquid outlet means from a positive displacement pump having an immediate step pumping rate which is relatively substantially larger than the delivery rate through the liquid outlet means comprising:[-]

a body having a hollow interior ~~with a resistance to flow therethrough substantially less than through the liquid outlet means;~~

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body for connection to the liquid outlet means, said liquid outlet means having a flow restrictor whereby a resistance to flow to the liquid outlet means is substantially greater than through the hollow interior of the body; and

pressure activated expansion compressible means which contracts to reduce the pressure surge of a liquid in within the body when the liquid is delivered by the pump at an increased pressure through the liquid inlet, and then gradually expands to decrease the pressure drop of the liquid within the body as it is delivered through the liquid outlet, so as to create maintain a substantially steady liquid pressure at the liquid outlet to provide the desired liquid delivery flow rate through the liquid outlet means.

2. (Currently Amended) An The assembly as claimed in claim 1, in which the expansion pressure compressible means comprises a gas bubble.

3. (Currently Amended) ~~An~~ The assembly as claimed in claim 2, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

4. (Currently Amended) ~~An~~ The assembly as claimed in claim 2, in which the expansion means comprises more than one gas bubble and the aggregate volume of the bubbles is a multiple of the volume of liquid dispensed in one step of the pump.

5. (Currently Amended) ~~An~~ The assembly as claimed in claim 2, in which the liquid outlet means comprises an elongate microchannel structure, the liquid pressure is such as to provide the necessary liquid pressure gradient between an entry port formed by the proximal end of the microchannel structure for connection to the liquid outlet and an exit port formed by the distal end of the microchannel structure.

6. (Currently Amended) ~~An~~ The assembly as claimed in claim 2 in which control means are provided, the control means comprising:[-]

means for sensing the flow conditions within the liquid outlet means; and
means for causing the pump to operate in response to the sensed flow conditions.

7. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which the pressure activated expansion means comprises an elastic membrane forming part of the body member.

8. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which the body comprises expandable tubing which forms the expansion means.

9. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which the liquid outlet means comprises an elongate microchannel structure, the liquid pressure is such as to provide the necessary liquid pressure gradient between an entry port formed by the proximal end of the microchannel structure for connection to the liquid outlet and an exit port formed by the distal end of the microchannel structure.

10. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which control means are provided, the control means comprising:[-]

means for sensing the flow conditions within the liquid outlet means; and
means for causing the pump to operate in response to the sensed flow conditions.

11. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the liquid outlet means are substantially equal.

12. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which the liquid outlet in the body includes a recirculation pipe connected between the liquid outlet and the body.

13. (Currently Amended) A liquid outlet link assembly to provide a steady liquid delivery output rate below 10 $\mu\text{l}/\text{minute}$ through a liquid outlet means from a positive displacement pump having an immediate step pumping rate which is relatively substantially larger than the delivery rate through the liquid outlet means comprising:[-]

a body having a hollow interior ~~with a resistance to flow therethrough substantially less than through the liquid outlet means;~~

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body for connection to the liquid outlet means, said liquid outlet means having a flow restrictor whereby a resistance to flow to the liquid outlet means is substantially greater than through the hollow interior of the body; and

a gas bubble in the body to create a liquid pressure at the liquid outlet to provide the desired liquid delivery flow rate through the liquid outlet means.

14. (Currently Amended) ~~An~~ The assembly as claimed in claim 11, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

15. (Currently Amended) ~~An~~ The assembly as claimed in claim 11, in which the liquid outlet means comprises an elongate microchannel structure, the liquid pressure is such as to provide the necessary liquid pressure gradient between an entry port formed by the proximal end of the microchannel structure for connection to the liquid outlet and an exit port formed by the

distal end of the microchannel structure.

16. (Currently Amended) ~~An~~ The assembly as claimed in claim 11, in which the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the liquid outlet means are substantially equal.

17. (Currently Amended) ~~An~~ The assembly as claimed in claim 1, in which the liquid outlet in the body includes a recirculation pipe connected between the liquid outlet and the body.

18. (Currently Amended) A pump assembly to provide a steady liquid delivery output rate below 10 μ l/minute comprising:[-]

a positive displacement pump;

a motor to operate the pump in a stepped manner such that the pump has an immediate step pumping rate which is relatively substantially larger than the liquid delivery output rate;

a liquid outlet means for the pump assembly;

a liquid outlet link assembly comprising:[-]

a body having a hollow interior with a resistance to flow therethrough substantially less than through the liquid outlet means;

a liquid inlet in the body of the link assembly for connection to the pump;

pressure activated expansion means in the body to create a liquid pressure at the liquid outlet to provide the desired liquid delivery flow rate through the liquid outlet means.

19. (Currently Amended) A The pump assembly as claimed in claim 18, in which the expansion means comprises a gas bubble.

20. (Currently Amended) A The pump assembly as claimed in claim 18, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

21. (Currently Amended) A The pump assembly as claimed in claim 18, in which the expansion means comprises more than one gas bubble and the aggregate volume of the bubbles is a multiple of the volume of liquid dispensed in one step of the pump.

22. (Currently Amended) A The pump assembly as claimed in claim 18, in which the pressure activated expansion means comprises an elastic membrane forming part of the body member.

23. (Currently Amended) A The pump assembly as claimed in claim 18, in which the liquid outlet means comprises an elongate microstructure, the liquid pressure is such as to provide the necessary liquid pressure gradient between the entry port formed by the proximal end of the

microstructure and the exit port formed by the distal end of the microstructure.

24. (Currently Amended) A The pump assembly as claimed in claim 18, in which control means are provided, the control means comprising:[-]

means for sensing the flow conditions within the liquid outlet means; and

means for causing the pump to operate in response to the sensed flow conditions.

25. (Currently Amended) A The pump assembly as claimed in claim 18, comprising:[-]
optical flow monitoring means connected to the liquid outlet means; and
control means connected to the optical flow monitoring means and the pump to operate the pump to provide the desired flow rate through the liquid outlet means.

26. (Currently Amended) A The pump assembly as claimed in claim 18, comprising pressure sensing means in the liquid outlet means and control means for operative connection to the positive displacement pump to cause the pump to operate on the pressure falling below a predetermined level.

27. (Currently Amended) A The pump assembly as claimed in claim 18, in which the pump is a syringe pump.

28. (Currently Amended) A The pump assembly as claimed in claim 18, in which the

volume pumped for each step of the syringe pump is greater than 0.1 μ l.

29. (Currently Amended) A The pump assembly as claimed in claim 18, in which the volume pumped for each step of the syringe pump is of the order of 0.2 μ l.

30. (Currently Amended) A The pump assembly as claimed in claim 18, comprising at least two syringe pumps feeding the one liquid outlet link assembly.

31. (Currently Amended) A The pump assembly as claimed in claim 18, in which the volume dispensed by at least one of the pumps for one step of that pump is substantially less than that of the other pumps.

32. (Currently Amended) A The pump assembly as claimed in claim 18, in which at least one additional electrokinetic pump is provided.

33. (Currently Amended) A The pump assembly as claimed in claim 32, in which the electrokinetic pump is an electroosmotic pump.

34. (Currently Amended) A The pump assembly as claimed in claim 32, in which the electrokinetic pump is an electrohydrodynamic pump.

35. (Currently Amended) A The pump assembly as claimed in claim 18, in which the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the liquid outlet means are substantially equal.

36. (Currently Amended) A The pump assembly as claimed in claim 18, in which the liquid outlet of the body includes a recirculation pipe connected between the liquid outlet and the body.

37. (Currently Amended) A microchannel structure assembly for the controlled flow of small volumes of liquids comprising:[
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an elongate enclosed microchannel structure having an internal bore less than $1000 \mu\text{m}^2$ cross-sectional area;

a positive displacement pump operating in a series of steps, each step operation of the pump dispensing a volume of the order of $0.01 \mu\text{l}$;

a liquid outlet link assembly comprising a body having a hollow interior with a bore considerably larger than the microchannel structure bore and thus preventing a resistance to flow therethrough substantially less than through the microchannel structure;

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body of the link assembly for connection to the microchannel structure;

and

pressure activated expansion means in the body of the link assembly to create a liquid

pressure at the liquid outlet to provide the desired liquid delivery output rate from the liquid outlet means.

38. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which the expansion means comprises a gas bubble.

39. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

40. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which the expansion means comprises more than one gas bubble and the aggregate volume of the bubbles is a multiple of the volume of liquid dispensed in one step of the pump.

41. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which at least portion of the body of the link assembly is expandable tubing which forms the expansion means.

42. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which the pressure activated expansion means comprises an elastics membrane forming part of the body member.

43. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which control means are provided, the control means comprising:-

means for sensing the flow conditions within the liquid outlet means; and
means for causing the pump to operate in response to the sensed flow conditions.

44. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, comprising:-

optical flow monitoring means connected to the liquid outlet means; and
control means connected to the optical flow monitoring means and the pump to operate the pump to provide the desired flow rate through the liquid outlet means.

45. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, comprising pressure sensing means in the liquid outlet and control means for operative connection to the positive displacement pump to cause the pump to operate on the pressure falling below a predetermined level.

46. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, comprising at least two syringe pumps feeding the one liquid outlet link assembly.

47. (Currently Amended) A The microchannel structure assembly as claimed in claim

37, in which the volume dispensed by at least one of the pumps for one step of that pump is substantially less than that of the other pumps.

48. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which the pump is a syringe pump.

49. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which at least one additional electrokinetic pump is provided.

50. (Currently Amended) A The microchannel structure assembly as claimed in claim 49, in which the electrokinetic pump is an electroosmotic pump.

51. (Currently Amended) A The microchannel structure assembly as claimed in claim 49, in which the electrokinetic pump is an electrohydrodynamic pump.

52. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which adjacent the liquid outlet of the liquid outlet link assembly, there is provided a flow balancing conduit, the cross-sectional area of the body adjacent the inlet substantially equaling the aggregate cross-sectional area of the microchannel structure and the recirculation conduit.

53. (Currently Amended) A The microchannel structure assembly as claimed in claim

37, the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the microchannel structure are substantially equal.

54. (Currently Amended) A The microchannel structure assembly as claimed in claim 37, in which the liquid outlet of the body includes a recirculation pipe connected between the liquid outlet and the body.